1952

The Chemical Control of Annual Weeds in Cotton.

Linton Eslic Cowart
Louisiana State University and Agricultural & Mechanical College

THE CHEMICAL CONTROL OF ANNUAL WEEDS IN COTTON

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Botany, Bacteriology,
and Plant Pathology

by
Linton Leslie Cowart
B. S., Louisiana State University, 1948
M. S., Louisiana State University, 1949
August, 1951

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

MANUSCRIPT THESES

Unpublished theses submitted for the master's and doctor's degrees and deposited in the Louisiana State University Library are available for inspection. Use of any thesis is limited by the rights of the author. Bibliographical references may be noted, but passages may not be copied unless the author has given permission. Credit must be given in subsequent written or published work.

A library which borrows this thesis for use by its clientele is expected to make sure that the borrower is aware of the above restrictions.

LOUISIANA STATE UNIVERSITY LIBRARY

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to Dr. S. J. P. Chilton for the many suggestions and assistance in the various phases of this study. Special thanks are also extended to Mr. L. E. Creasy for his assistance in carrying out the various phases of the work, to Dr. C. W. Edgerton for his advice and encouragement, to Dr. L. H. Flint for his helpful criticisms in the final preparation of this manuscript, and to Dr. E. C. Tims for his assistance with the photography.

TABLE OF CONTENTS

		Page
I.	ACKNOWLEDGMENTS	ii
II.	INFORMATION REGARDING THE CHEMICALS	iv
III.	LIST OF TABLES	vii
IV.	LIST OF ILLUSTRATIONS	x
V.	ABSTRACT	xi
VI.	INTRODUCTION	1
VII.	REVIEW OF LITERATURE	4
VIII.	MATERIALS AND METHODS	11
	A. One-fiftieth Acre Plot Studies	11
	B. One-fourth Acre Plot Studies	13
	C. Field Scale Tests	18
IX.	EXPERIMENTAL RESULTS	23
X.	DISCUSSION	41
	A. Small Plot Studies	41
	B. One-fourth Acre Plots and Field Scale Tests	43
XI.	SUMMARY	53
XII.	CONCLUSIONS	55
XIII.	ILLUSTRATIONS	56
XIV.	SELECTED LITERATURE	61
XV.	AUTOBIOGRAPHY	66

INFORMATION REGARDING THE CHEMICALS

Dinitro Type

Sinox W: Ammonium dinitro ortho secondary butyl phenol, 13 per cent active ingredient. Furnished by Standard Agricultural Chemical Co.

Dow Selective: Ammonium dinitro secondary butyl phenol, 13.7 per cent active ingredient. Furnished by the Dow Chemical Co.

Premerge: Ethanol amine salt of dinitro secondary butyl phenol, 30 per cent active ingredient. Furnished by the Dow Chemical Co.

Koppers K1131: Ammonium dinitro ortho isopropyl phenol, 30 per cent active ingredient. Furnished by the Koppers Chemical Co.

Trichloroacetic Acid Type

Sodium T.C.A.: Sodium salt of trichloroacetic acid, 90 per cent active ingredient. Furnished by the E. I. duPont de Nemours and Co.

Ammonium T.C.A.:	Ammonium salt of trichloroacetic acid, 90 per cent active ingredient. Furnished by the E. I. duPont de Nemours and Co.
Isopropyl T.C.A.:	The isopropyl ester of trichloroacetic acid, 80 per cent active ingredient. Furnished by General Chemicals Co.
Chlorosal A:	Alpha Hydroxy Beta trichloro ethyl sulfonic acid, 20 per cent active ingredient. Furnished by the Pittsburgh Agricultural Chemical Co.
S A C #200:	Experimental herbicide #200, 60 per cent active ingredient. Furnished by the Standard Agricultural Chemical Co.
C & C #2:	Experimental herbicide #2, 75 per cent active ingredient. Furnished by the Carbon and Carbide Co.

Other Chemicals

Sharples EC3740:	Disodium 3, 6- endoxohyexahydrophthalate, 30 per cent active ingredient. Furnished by Sharples Chemical Co.
Maleic Hydrazide:	Diethanolamine salt of maleic hydrazide, 30 per cent active ingredient. Furnished by the Naugtuck Chemical Division of the U. S. Rubber Co.

Herbicidal Oils

LHH1: Lion herbicidal hydrocarbon #1, 23 per cent aromatics, boiling range 300-400° F. Furnished by the Lion Oil Co.

WS1918: Herbicidal oil, 24 per cent aromatics, boiling range 300-400° F. Furnished by the Esso Standard Oil Co. of New Jersey.

LIST OF TABLES

Page

I. Results Obtained from Studies with 4 Dinitro Herbicides, on the Control of Grass and Broad-leaved Weeds in Cotton: (1) Dow Selective; (2) Premerge; (3) Simox W; (4) Koppers K1131. Values are Weeds Counted on June 8, 1950..... 24

II. Results Obtained from Studies with 5 Herbicides on the Control of Grass and Broad-leaved Weeds in Cotton: (1) Sharples EC3740; (2) Dow Selective; (3) Premerge; (4) Simox W; (5) Koppers K1131. Values are Weed Counts Made on June 15, 1950..... 25

III. Results Obtained in Studies on Weed Control in Cotton with the Dinitro Herbicide "Premerge", at Two Rates of Application. Values Shown are Weed Counts Made on May 11, 1950..... 26

IV. Results Obtained in Studies on Weed Control in Cotton with 6 TCA or TCA like Herbicides: (1) Sodium TCA; (2) Ammonium TCA; (3) Isopropal TCA; (4) Carbide and Carbon Number 2; (5) Standard Agricultural Chemicals Number 200; (6) Chlorosal A. Values Shown are Weeds Counted on May 11, 1951..... 27

V. Results Obtained in Studies on Weed Control in Cotton with 4 Herbicides: (1) Sodium TCA; (2) Sharples EC3740; (3) Maleic Hydrazide; (4) Carbide and Carbon Number 2. Values Shown are Weed Counts Made on June 8, 1950..... 28

VI. Results Obtained in Studies on Weed Control in Cotton with 3 Herbicides: (1) Sodium TCA; (2) Sharples EC3740; (3) Maleic Hydrazide. Values Shown are Weed Counts Made on May 11, 1950..... 29

VII. Results Obtained in Studies on Weed Control in Cotton with Blanket and Drill Applications of the Dinitro Herbicide "Premerge". Values Shown are Weed Counts Made on May 10, 1950..... 30

LIST OF TABLES (Continued)

Page

VIII. Results Obtained in Studies on 2 Methods of Application of the Pre-emergence Chemical "Premerge". (1) Blanket Application; (2) Drill Application. Values Shown are Weeds Counted June 12, 1950..... 31

IX. Results of Yield Tests on Cotton Treated with 4 Methods of Controlling Grass and Broad-leaved Weeds: (1) Blanket Application of "Premerge", Followed by Flame Cultivation; (2) Drill Application of "Premerge", Followed by Oil and Flame Cultivation; (3) Drill Application of "Premerge", Followed by Oil Only; (4) Normal Control with Hand Hoeing..... 32

X. Results Obtained from Studies with 4 Methods of Weed Control and the Cost per Acre: (1) Pre-emergence Followed by Post-emergence and Flame Cultivation; (2) Pre-emergence Followed by Post-emergence Oil; (3) Post-emergence Oil; (4) Hand Hoeing..... 33

XI. Results Obtained from Studies on Injury to Cotton When Post-emergence Application of Herbicidal Oils Were Used Following Pre-emergence Treatments and Where Post-emergence Oils Were Used Alone. Values Shown are Total Number of Stalks Observed on 200 Feet of Row in Each Plot..... 34

XII. Results Obtained from Yield Tests on Cotton Treated with Pre-emergence Followed by Post-emergence Chemicals and Post-emergence Chemicals Alone. Values Shown are Yields in Pounds of Seed Cotton per Acre..... 35

XIII. Results Obtained from Studies on Injury to Cotton from 2 Herbicidal Oils at 2 Rates of Application: (1) LHH1; (2) WS1918. Values Shown are Total Number of Stalks Observed on 200 Feet of Row in Each Plot..... 36

XIV. Results Obtained from Yield Tests on Cotton Treated with 2 Herbicidal Oils at 2 Rates of Application: (1) LHH1; (2) WS1918. Values are Yields in Pounds of Seed Cotton per Acre..... 37

LIST OF TABLES (Continued)

		Page
XV.	Results Obtained from Field Scale Studies on the Control of Annual Grass and Broad-leaved Weeds in Cotton. Cotton Treated with Pre-emergence and Post-emergence Chemicals. Values are Weeds Counted on August 16, 1950, Approximately 10 Days After "Layby".....	38
XVI.	Results of Yield Tests, Cost of Hand Labor and Number of Cultivations in Studies on Weed Control in Cotton Using Pre-emergence Dinitro and Post-emergence Oil Sprays.....	39
XVII.	Rainfall Data Recorded at St. Joseph, Louisiana, for the Months April Through September.....	40

LIST OF ILLUSTRATIONS

Plate		Page
I.	Showing Injury to Stand and Poor Weed Control Resulting from 12 Pounds per Acre of Sodium TCA. Treated Left of Stake "3", Untreated Right	56
II.	Showing Tractor Drawn Sprayer Spraying Four Cultipacked Rows with Pre-emergence Chemical	57
III.	Showing Results of Pre-emergence, Drill Application of "Premerge". Treated April 15, Photo May 20. Treated 12-14 Inches Right of Stake, Untreated Middle Left of Stake	58
IV.	Showing Stem Injury Resulting from Post-emergence Directed Applications of Herbicidal Oil. Figure 1. LHHl, 5 Gallons per Acre, 3 Applications. Figure 2. LHHl, 5 Gallons per Acre, 3 Applications Followed by 4 Flame Cultivations. Figure 3. LHHl, 5 Gallons per Acre, 4 Applications. Figure 4. LHHl, 10 Gallons per Acre, 4 Applications	59
V.	Showing Results of Pre-emergence Application Followed by One Post-emergence Application of Oil. Uncultivated Control on Left. Treated, Middles Cultivated, Drills Undisturbed, on Right	60

ABSTRACT

Seed-bed preparation, methods of application, and the relation of soil moisture to satisfactory weed control have been major problems confronting researchers experimenting on weed control in large-seeded crops such as cotton.

In the tests reported here-in, studies on the chemical control of annual weeds in cotton were carried out during the growing season of 1950.

Field tests were carried out at the Red River Experiment Station, the North East Louisiana Experiment Station, and at Baton Rouge. Large scale tests were carried out at Ferriday, Lake Providence and Monroe, Louisiana. The dinitro herbicides, trichloroacetate and several related compounds were applied as pre-emergence residual sprays. Post-emergence directed application of several aromatic oils was studied. Seed-beds were prepared and compacted to uniform smoothness with the cultipacker or a wide press wheel on the planter. The per cent of weed control was computed from the number of weeds counted in the treated and the control plots either several weeks after treatment, or after "layby" time.

Satisfactory weed control for 3 to 5 weeks resulted when 6 pounds per acre of the dinitro herbicides were applied. Heavy rains

immediately following chemical applications did not reduce weed control significantly.

The trichloroacetates gave satisfactory control of grass weeds, but chemical injury seems to preclude the use of such herbicides for pre-emergence weed control in cotton.

Four post-emergence applications of the aromatic oils, LHHl and WS1918 at five gallons per acre gave weed control that was less satisfactory than was obtained by hand hoeing. Injury to the cotton stems resulted under some conditions when more than three such applications of either oil were used.

The combined and timely use of pre-emergence and post-emergence chemicals followed by flame cultivation resulted in weed control superior to that obtained using hand labor. Further, this means of weed control was shown to be less expensive than the conventional methods.

Tentative recommendations were made for the use of chemicals for weed control in cotton production.

INTRODUCTION

Weeds are recognised as pests that seriously reduce the productive capacity of agricultural lands throughout the world. Weeds compete with crop plants for water, nutritive materials and space, and thus are a major problem in crop production. The control of these pests has been the object of many researches, in which both mechanical and chemical means have received much attention.

The discovery of the selective herbicidal action of various chemicals broadened the scope of weed control and revealed possibilities for this type of weed control in almost every crop grown. Rapid advances have been made in the study of appropriate methods of application of herbicides and in the diagnosis of plant responses to such chemicals. These, plus the advent of mechanized agriculture have emphasized the need for new means of weed control in cultivated crops.

Cotton, one of the world's largest crops, has been found to be very sensitive to most herbicidal chemicals and for a time it was difficult to visualize any weed control program based on the physiological resistance of this crop plant. However, the development of new techniques of application and usage of herbicides modifies the prospect for the chemical control of weeds in sensitive crop plants. Contact pre-emergence, pre-emergence residual, post-emergence, and post-emergence directed applications of spray materials have been

developed.

The contact pre-emergence spray is the term used when herbicidal chemicals are applied to weeds after slowly germinating crop plant seeds have been planted but before the seedlings have emerged through the soil. The pre-emergence residual sprays are those applied immediately or soon after planting crop seeds. These sprays are designed to kill weed seed or seedlings before they emerge. The chemicals in this case would remain in the soil for varying lengths of time, often long after the crop has emerged. Post-emergence applications are sprays applied any time after the crop plants have emerged. The success of this technique depends upon the selectivity of the herbicide and the relative physiological resistance of the crop plant. Post-emergence directed sprays are those applied any time after the crop plants emerge, but directed in such a manner as not to cause the chemical to come in contact with the foliage of the crop plant. Differences in the sizes of weed plants and crop plants and the relative resistance of the stems of the crop plant are important factors in weed control when this method is used.

Since cotton seeds germinate relatively rapidly, the application of contact pre-emergence herbicides would appear to be a serious risk to the crop. The sensitiveness of cotton foliage to the known herbicidal chemicals would seem to eliminate post-emergence applications for weed control in this crop. However, the cotton plant, having a large seed is usually seeded one to two inches deep in the soil. This is known to be below the region in the soil from which most

of the weed seeds germinate, and weed control with pre-emergence residual applications appears to be possible. Further, when the residual effect of applied herbicides no longer exists the application of post-emergence directed sprays may be possible. It was the purpose of these studies to determine the feasibility of weed control in cotton by pre-emergence residual, and post-emergence directed applications of herbicidal chemicals.

REVIEW OF LITERATURE

Weeds competing with crop plants for space and nutrients reduce both the quantity and quality of crops produced. More work on herbicides and more in the way of scientific and practical achievement with herbicides has taken place in the past decade than at any time in history. No doubt the urgent need for increased agricultural raw materials, the discovery of new chemicals, and a shortage of farm labor have done much to stimulate interest in weed control.

Since Hamner and Tukey, 1944, (15) published their paper on the herbicidal action of 2,4-D on bindweed, most of the research in the country on herbicides has centered around 2,4-D. However, before this time there was introduced into this country, from France, a compound called Sinox (19, 36).

Sinox (sodium-dinitro-orthocresylate) is a coal tar derivative in the form of a yellow dye. This compound was first used as a herbicide in France in 1933 and as a spray for weed control in the United States in 1938. This material had been used in extensive field tests in California (48), North Dakota (19), Montana (29), and Canada (51). Seegate and Raynor (50) obtained successful results in the control of weeds in cereals and flax with this chemical.

In the early developmental period, Sinox and its salt derivatives were studied mainly as contact herbicides. The success of

these applications depended upon the difference in the susceptibility of the weeds and crop plants. Several workers observed that Sinox killed only the broad-leaved annual weeds and had little effect on perennial grasses and woody herbs. Also it was observed that the young seedling weeds were most sensitive. Using Sinox as a direct spray, Helgeson and Gerbracht (19) increased the yields of flax 232 per cent. In 1945 Litzenberger et al. (29) studying weed control in flax and peas, obtained yield increases up to 264 per cent. These authors, however, caution that flax and peas should never be sprayed with Sinox before the plants reach a height of 3 inches, and never after bud formation. Schwendiman, et al. (39) studied the effects of Sinox on legume seedlings, weeds, and crop yields in Wisconsin, and reported that Sinox killed 0 to 70 per cent of alfalfa and red clover plants up to 4 weeks of age, but that as these plants grew older they developed a high resistance to this herbicide. Bond and Schultz (7) used Sinox for killing the tops of potatoes before harvest time, and found that the effect of this chemical was increased by the addition of ammonium sulfate.

Robbins, et al. (36) point out that Sinox is non-corrosive and relatively non-poisonous, and is an organic compound which, in the soil, is slowly decomposed by micro-organisms and leaves no toxic residue. Further tests of Sinox in soils indicated that the nitro groups might be split away and made available to plants.

The discovery that the activity of Sinox was increased by the addition of the activator ammonium sulfate led to the formulation of

several salts of the dinitro chemicals which do not require the addition of an activator. This, coupled with the development of new techniques of application of spray materials, has increased the possibilities for weed control with the dinitro herbicides.

Hedlin (18) pointed out three possible procedures in weed control with onions: pre-emergence applications, post-emergence applications, and destruction of weeds in the fields at harvest time. This may well be the case in most crops.

Barrons (4) described two types of pre-emergence sprays (1), the contact pre-emergence spray and (2), the residual pre-emergence spray. The contact pre-emergence spray is the term used when spray materials are applied to weeds after slowly germinating crop plant seeds have been planted, but before the seedlings have emerged through the soil. Residual pre-emergence sprays are those applied immediately or soon after planting. These sprays are designed to kill the weed seed or seedlings before they come up. The chemicals in this case would remain in the soil for varying lengths of time, often long after the crop has emerged. Thus a selective action is highly desirable. Barrons further points out that chemicals showing promise for this type of treatment include 2,4-D and certain of the phenolic compounds which include the dinitro compounds.

When phenolic compounds are used for residual pre-emergence control, it is important to understand that this method is especially effective with large seeded crops (5). Under field conditions the selectivity is apparently a matter of depth protection, so that

small-seeded weeds and crop plants are killed. The top growth pushing through the surface layers of soil containing the toxicant apparently does not absorb enough of it to cause injury. The waxy leaf and stem surfaces will not permit the entry of ionic materials such as the phenolic salts. Roots, which lack a waxy covering, do absorb salts and germinating seeds are thus killed. Unlike 2,4-D, the phenolic compounds have no systemic effect, but are effective by local and acute toxicity (4).

Good seed-bed preparation has been pointed out as essential to success with residual pre-emergence methods (8, 9, 10, 12, 13, 19, 24, 25, 32). Chemicals applied as sprays will not penetrate surface lumps, while good control is obtained on the level areas (8). Barrons (2) further points out that the phenolic compounds should be extensively tried under a variety of conditions before general recommendations are made.

In another publication Barrons (5) states that the toxicity of the phenolic compounds is the result of their molecular configuration and not the presence of a toxic element. Thus the phenolic compounds are effective against seedling of all species, but since they undergo decomposition rather quickly in the soil, toxic residues are temporary.

Warren and Buchholtz (49), working with dinitro sprays for weed control in canning peas, reported satisfactory results. These authors suggest that Dow Selective may have longer residual toxicity than Sinox W. Cowart et al. (8) reported that the dinitro compounds gave satisfactory weed control under a variety of conditions, but

that high rainfall reduced their effectiveness.

Litsenberger (29) et al. reported satisfactory weed control in pea crops, using Sinox and Sinox W, the dominant weed was wild mustard. Litsenberger points out that the result may have been partially due to the generally drier weather conditions under which the work was done. Lochman (30), working on pre-emergence spraying for weed control in vegetable crops, stated that Sinox was a selective spray and would not control grasses. These authors further pointed out that spray schedules would have to be worked out according to the crop, prevailing temperatures, soil type, planting depths, and soil mosture.

A number of other workers have reported satisfactory weed control from the use of dinitro compounds as pre-emergence sprays. Barrons and Grigsby (6) reported satisfactory weed control and no injury to canning peas. Schaffer (37) used dinitro sprays and controlled weeds well in beds of asparagus seedlings, without injury to the asparagus.

Leonard (25) et al. reported that dinitro sprays, applied at a rate of approximately 6 pounds per acre, controlled all annual weeds in cotton for more than six weeks. No injury was reported and the treated cotton grew in the normal manner. In other tests the same authors reported no injury to peas treated in the same way. Since that time other authors have reported similar results (1, 8, 9, 10, 13, 14, 16, 17, 22, 24, 31).

Leonard (27) reported that cotton was injured in one test in

which 6 pounds per acre of the dinitro compounds were applied. Here the cotton was planted late and the soil was loose and dry at the time of application of the chemical. The weed control in this test was unsatisfactory and Leonard states that the activity of the dinitro sprays increased as the temperature increased. He reported little difference in the control of weeds with the salts and phenols of dinitro compounds. Sodium pentachlorophenate controlled the weeds longer and more completely than the dinitros in some tests, but gave less satisfactory control in other tests. Cotton was injured in one test, but not in others.

Albert (1) reported that Dow Selective at 3 and 6 pounds per acre and Sodium pentachlorophenate at 5, 10, and 20 pounds per acre gave unsatisfactory weed control. Albert believed that the lack of rain and dry soil contributed largely to the result. No injury to cotton was reported.

Cowart (9), et al. (1950) reported that when soil moisture was below 5 per cent in the upper two inches of soil, severe injury resulted from pre-emergence dinitro sprays of 6 pounds per acre. Cowart pointed out, however, that under the same conditions 4 pounds per acre gave satisfactory weed control without significant injury. In the same publication the authors reported good weed control using post-emergence directed sprays of the aromatic oil, LHHl. They further suggested the use of post-emergence oils as a means for complete weed control in cotton.

Later Talley (43, 44, 45), Hinkle (22, 23), Holstun, et al.

(24), Leonard and Harris (28), McMurray (31), Ratcliff et al. (35) and Creasy et al. (13), reported satisfactory weed control using pre-emergence dinitro chemicals followed by post-emergence oils, or by the use of post-emergence oils alone.

Some of these authors have found significant differences in results obtained from trials with the various dinitro formulations when equivalent rates of the active ingredient were applied. Varying reports have been published regarding the effect of repeated herbicidal application of aromatic oils. Talley and his co-workers (44) claim no significant injury with as many as six applications of five gallons each. Holstun et al. (24) and Ratcliff et al. (35) report serious injury when more than three applications of these oils were applied following the use of pre-emergence chemicals.

MATERIALS AND METHODS

A. One-Fiftieth Acre Plot Studies

All small plots were of one-fiftieth acre. The plots were randomized and comprised three replications. Seed beds were plowed, disked and worked into 40 inch rows approximately three weeks before planting time. Disking or disking and dragging immediately before planting was carried out to shape the seed bed for planting. Planting was with a two row tractor-mounted planter with runner wing and hill dropping attachments, and on rows only slightly higher than the middles. The surface of the planted bed was firmed and smoothed with a drum type cultipacker.

Materials were applied as a blanket spray with a three gallon compressed air hand sprayer. Total volume of application was 60 gallons per acre. Observations and weed counts were made at various dates. All tabular results of actual counts made relate to the weeds on an average of 1 square yard, (three, 1/3 square yard counts) counted in each of three replications. Details of the tests in the small plot studies are as shown below:

Test 1. This test was designed to compare the following dinitro-type chemicals as pre-emergence residual treatments: Dow

Selective, Premerge, Sinox W, and Koppers 1131. All materials were applied at equivalent rates based on percent active ingredient. The test was located at Baton Rouge, Louisiana; cotton was planted April 28, treated April 29, 1950, with weed count data recorded on June 8. The results are shown in Table 1.

Test 2. Details of this test are the same as for Test 1, except for the inclusion of one additional chemical, Sharples EC 3740, at the rates shown in Table 2. The test was located at St. Joseph, Louisiana; cotton was planted May 22, treated May 23, and weed count data were recorded on June 15, 1950. The results are shown in Table 2.

Test 3. Premerge was tested at 4 and 6 pounds per acre blanket rates as a pre-emergence residual treatment. Each rate was repeated three times for a total of nine replications per treatment. The plots received a total of eight inches of rain between time of treating and time the data were recorded. The test was located at St. Joseph, Louisiana; cotton was planted April 14, 1950, treated April 15 and the weed data were recorded on May 11. The results are shown in Table 3.

Test 4. This test was designed to compare the following TCA-like herbicides as pre-emergence residual treatments: Sodium TCA, Am TCA, Ip TCA, C and C #2, SAC #200, and Chlorosal A. All materials were applied at blanket rates of 4, 8, and 12 pounds of active ingredient per acre. The test was located at St. Joseph, Louisiana; cotton was

planted April 14, treated April 15, and the weed data were recorded on May 11, 1950. The results are shown in Table 4.

Test 5. This test was designed to compare the following four herbicides as pre-emergence residual treatments. Sodium TCA, EC 3740, Maleic Hydrazide, and C and C #2. All materials were applied as blanket sprays with treatments and rates as shown in Table 5. The test was located at Baton Rouge, Louisiana; cotton was planted on April 28 and treated on May 1; the weed data were recorded on June 8, 1950. The results are shown in Table 5.

Test 6. Details of this test are the same as for Test 5 and included the following three materials: Sodium TCA, EC 3740 and Maleic Hydrazide. The test was located at St. Joseph, Louisiana; cotton was planted and treated April 14, 1950, and weed counts were recorded on May 11. The results are shown in Table 6.

B. One-Fourth Acre Plot Studies

These tests consisted of a series of one-fourth acre plots designed: (1) to permit the evaluation of weed control gained by various combinations of pre-emergence chemicals, post-emergence chemicals, flame cultivation, and mechanical cultivation; (2) to allow the determination of injury, if any, to crop plants by various rates of post-emergence oils when used alone and when followed by flame

cultivation; and (3) to determine the relative cost of materials used for weed control in the various treatment combinations as compared to the cost of control by ordinary plantation practices which included hand hoeing.

Seed beds were prepared in the same manner for all the one-fourth acre tests. The soil was thoroughly plowed, disked and worked into 40 inch rows approximately three weeks before planting. Disking or disking and dragging immediately before planting was carried out to shape the seed bed for planting. Planting was by a two row tractor-mounted planter with runner wing and hill dropping attachments. The rows were only slightly higher than the middles. The surface of the planted bed was firmed and smoothed with a drum type cultipacker before the sprays were applied.

Pre-emergence sprays were applied with a tractor-mounted sprayer as an operation separate from planting. Blanket sprays were applied with a rear mounted boom employing four nozzles spaced 20 inches on center (for 40 inch rows) and adjusted to the proper height for single coverage. Drill sprays were applied with one nozzle centered over each row and adjusted in height to cover a 12-14 inch band. All pre-emergence sprays were applied in a total volume of 50 gallons per acre on a blanket basis with water as the diluent. Calibration included accurate determination of tractor speed under field conditions and adjustment of pressure to give the required nozzle discharge for the speed of travel. Actual discharge of nozzles was measured for a period of several minutes and adjustments were made when necessary.

The total volume applied per plot was checked for each spraying. The spray applications were carried out at speeds varying from 3 to 4.5 miles per hour, with pressures of 20/40 pounds per square inch.

Post-emergence oil sprays were applied undiluted, from one nozzle carried on each side of the row. The type of spray shoes developed at Delta Branch Experiment Station at Stoneville, Mississippi, was used (46). Nozzles were set in such a manner that the flat spray pattern was horizontal and directed across the row at a height of approximately 1 inch above the soil surface. The nozzle on one side of the row was set to lead the nozzle on the opposite side of the row by several inches. The details of the one-fourth acre tests are shown below.

Test 7. This test was designed to permit a comparison of the treatment combinations listed below. The test was located at St. Joseph, Louisiana; cotton was planted on April 13, and pre-emergence sprays were applied on April 14, 1950. All rates for pre-emergence treatments are given on a blanket basis with one-third of the total area treated on drill spray plots. Rates shown for post-emergence oils are total volumes applied to an 8 inch band of the drill area. Rainfall at the Northeast Louisiana Experiment Station, St. Joseph, Louisiana, is shown in Table 17.

Treatments:

1. Dinitro, 6 lbs. per acre, blanket application, plus flame cultivation.

2. Dinitro, 6 lbs. per acre, drill application following by oil (if necessary) plus flame cultivation.
3. Dinitro, 6 lbs. per acre drill application, plus oil as needed (3-5 applications at 5 gallons per acre).
4. Dinitro, 8 lbs. per acre, blanket application, plus flame cultivation.
5. Dinitro, 8 lbs. per acre, drill application followed by oil (if necessary) plus flame cultivation.
6. Dinitro, 4 lbs. per acre drill application, oils applied (3-5 times at 5 gallons per acre as needed).
7. Untreated check.
8. Normal check (plantation practices).
9. Oil, LMHl (5 gallons per acre drill only) as needed.
10. Oil, WS 1918 (5 gallons per acre drill only) as needed.

Results of weed counts made on May 10, 1950, for the pre-emergence treated plots only are shown in Table 7. Due to severe damping off this test had to be plowed up and no further data were recorded.

Test 8. The treatments for this test are identical with those of Test 7. The test was located at Baton Rouge, Louisiana. The cotton was planted on May 8 and pre-emergence sprays were applied on May 9. Weed counts were made on June 12 for that portion of the test which received pre-emergence spraying. Results of these counts are shown in Table 8.

Because of wet conditions no further treatments or cultivations were carried out until June 26 and 27, at which time the middles of all plots excepting plots 1 and 4 were cultivated. Oil was applied to plots 2, 3, 5, and 6 at the rates outlined. Plots 1 and 4 were flame cultivated on July 1 and July 15. Plots 1, 2, 4, and 5 were flame cultivated on July 10. No subsequent treatments followed except cultivation of the middles with sweeps. Yield data for this test are shown in Table 9.

Test 9. This test was identical to Test 7 above and was carried out at St. Joseph, Louisiana. The cotton was planted on May 23 and pre-emergence sprays were applied May 24.

Weed counts were made on August 2, approximately 10 days after the last cultivation. The weeds present in the drill of 616 row feet of each plot were counted and are recorded in Table 10. Stalk injury observations were made on August 2 for all plots treated with oils or oils and flame in combination. These observations were made on 200 row feet of each plot, and percentages of injury were based on the total stalks counted in each plot. These results are recorded in Table 11. The yield data are presented in Table 12.

Comparative cost data for materials and hand labor were calculated for each plot in the test. Included are costs of pre-emergence and post-emergence sprays, fuel for flame cultivation and labor for hand hoeing. These results are also presented in Table 10.

Test 10. This test consisted of a series of one-fourth acre plots designed to allow the determination of injury to the crop plants when treated with different rates of post-emergence oils as a weed control measure. LNNl and WSl918 oil was applied to cotton at rates of 5 and 10 gallons per acre beginning when the cotton was 3 weeks old. Four applications were made at weekly intervals. The cultivation of all plots was identical. The test was located at St. Joseph, Louisiana, and the cotton was planted on May 23. Stand and injury counts made on August 2 are presented in Table 13. Yield data from these plots are presented in Table 14.

C. Field Scale Tests

These tests consisted of plots approximately 25 acres in size and were conducted in cooperation with plantation owners and managers at three widely separated locations in the state. Practices and procedures that had proven best in the 1948 and 1949 experimental work (8, 9) were included to test their practicability when incorporated with general practices of cotton producing farms. Pre-emergence spraying, post-emergence oil applications and flame cultivation were included as weed control measures. Cotton was hill dropped in all tests.

Pre-emergence sprays were applied as drill applications to a 12-14 inch band on seed beds that had been firmed and smoothed with a cultipacker or wide planter press wheel. The rate of application

was 6 pounds in a total volume of 50 gallons per acre on a blanket basis, but the actual material applied was 2 pounds per acre diluted with water to a total volume of 16.6 gallons per acre. The material used was "Premerge" and application was by supervised plantation labor. Post-emergence oils were applied as directed sprays to an 8 inch band of the drill at a total volume of 5 gallons per acre undiluted. On each test LAN1 oil was applied to approximately half of the test and the oil, WS 1918 to the remainder. Where available, flame cultivation was utilized as soon as the cotton was large enough.

Location, planting date and names of cooperators are as listed below, followed by details for each test:

Test No.	Planting Date	Plot Size	Location	Cooperator
11	April 15	22.5 A	Ferriday, La.	S. P. Johnson
12	May 10	22.5 A	Ferriday, La.	S. P. Johnson
13	April 20	25 A	Monroe, La.	Neal McHenry
14	May 12	50 A	Gaseway, La.	Robert Amacker

Test 11. Pre-emergence sprays were applied to this test on April 15. The seed bed was flat and loose and no packing or smoothing operation preceded spraying. This plot received heavy rain on April 16 and 17. Continued heavy rains delayed any cultivation or oil application until May 18. At this time 5 gallons per acre of oil were applied to the drills, with a two row cultivator, equipped with commercially available spray shoes.

The first cultivation for control of weeds in the middles was on May 18, but was a separate operation from oiling. Weeder knives were employed initially but did not prove effective on the size of weeds present, and disk hillers set to cut very shallow were substituted. The first cultivation did not thoroughly remove all the weeds present in the middles, and a second cultivation was carried out by the plantation manager on May 20. This operation was with shovels set deep, and resulted in the cotton being heavily "dirted". No future oil applications were possible and no flame cultivation was utilized on this test. Two more cultivations of the middles occurred before "layby" time. Yields and number and costs of hand hoeings on this test as compared with two check areas are shown in Table 16. Final weed count data on this test are shown in Table 15.

Test 12. Cotton for this test was planted on May 8 and pre-emergence sprays were applied on May 10. The cotton was hill dropped and the seed bed was smoothed and firmed with a cultipacker before spraying. This test plot received more than one inch of rain on May 14. The first cultivation and first oil application were carried out on June 9. The seed bed remained in good condition for oiling or flaming and the first flame cultivation was on June 26. One light hand hoeing the week of July 2 was all the hand labor necessary for this plot. A total of three cultivations of the middles were made before "layby" time. Yields and number and costs of hand hoeings on this test as compared with two check areas are shown in Table 16.

Final weed count data are included in Table 15.

Test 13. Cotton for this test was planted on April 20 on slightly raised beds and treated on April 21. The cotton was hill dropped and the bed was firmed and smoothed with a two drum cultipacker. A light rain (less than ½ inch) occurred on April 22. A very heavy rain (over 5 inches) on April 29 and 30 caused the entire seed bed to be covered with water.

The first cultivation of the middles was on May 9 with sweeps that were not flat enough to prevent the formation of a ridge on each side of the cotton row. The first application of oil was on May 19, but coverage was not satisfactory because of the ridges left by cultivation and only 7 acres were treated at this time with LHHl. A second cultivation utilising weed knives was made on May 22, and helped to remove much of the ridge thrown up by the first cultivation. Oil application to the remainder of the test was on May 23 when half of the area was sprayed with LHHl and half with WS 1918. No data are available for this test.

Test 14. The cotton for this test was planted on May 12 and pre-emergence sprays were applied on the same day. The seed bed at time of planting was completely flat. The first oil application was on June 2, at which time approximately 8 acres were sprayed with LHHl oil at a rate of 5 gallons per acre. Final weed counts made on August 16 are recorded in Table 15. Wet conditions for a period of approxi-

mately two weeks prevented any tractor operation in the field. By this time the Johnson grass had reached a size too large to be effectively reduced by oiling and no further applications were made. Yield data from this test were unavailable.

EXPERIMENTAL RESULTS

The results obtained from experiments outlined in the "Materials and Methods" are shown in the following series of tables.

Table I. Results Obtained from Studies with 4 Dinitro Herbicides, on the Control of Grass and Broad-leaved Weeds in Cotton: (1) Dow Selective; (2) Premerge; (3) Sinox W; (4) Keppers K1131. Values are Weeds Counted on June 8, 1950.

Treatment	Rate in pounds per acre	Average Weeds per Square Yard*		Per cent of Weed Control*	
		Broad leaved	Grasses	Broad leaved	Grasses
Dow Selective	4	41	8	16.3	84.0
	6	18	8	63.3	84.0
	8	7	1	85.7	98.0
Premerge	4	20	13	38.8	74.0
	6	20	4	38.8	82.0
	8	4	3	91.8	94.0
Sinox W	4	21	17	57.1	66.0
	6	9	2	31.6	96.0
	8	19	2	61.2	96.0
	—	—	—	—	—
Keppers K1131	4	17	26	65.3	48.0
	6	18	18	63.3	64.0
	8	20	7	38.8	86.0
Control		49	50	—	—

* Average weeds per square yard computed from total weeds counted in one square yard of three replications. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table II. Results Obtained from Studies with 5 Herbicides on the Control of Grass and Broad-leaved Weeds in Cotton: (1) Sharples EC3740; (2) Dow Selective; (3) Premerge; (4) Sinox W; (5) Koppers K1131. Values are Weed Counts Made on June 15, 1950.

Treatment	Rate per acre	Average Weeds per Square Yard*		Per cent of Weed Control*	
		Broad leaved(1)	Grasses(2)	Broad leaved	Grasses
Sharples EC3740	1 lb.	103	65	18.9	—
	2 lb.	113	98	11.0	—
	3 lb.	80	58	37.0	—
Dow Selective	4 lb.	36	15	71.7	69.4
	6 lb.	22	13	82.7	73.5
	8 lb.	22	13	82.7	73.5
Premerge	4 lb.	93	5	26.8	89.8
	6 lb.	57	3	55.1	93.9
	8 lb.	33	6	74.0	87.8
Sinox W	4 lb.	129	33	none	32.7
	6 lb.	34	23	73.2	53.1
	8 lb.	11	4	91.3	91.8
Koppers K1131	4 lb.	61	23	52.0	53.0
	6 lb.	88	5	30.7	89.7
	8 lb.	42	4	66.9	91.8
Control		127	49		

* Average weeds per square yard computed from total weeds counted in one square yard of three replications. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table III. Results Obtained in Studies on Weed Control in Cotton with the Dinitro Herbicide "Premerge", at Two Rates of Application. Values Shown are Weed Counts Made on May 11, 1950.

Treatment	Rate per acre	Average Weeds per Square Yard*		Per cent of Weed Control*	
		Broad leaved	Grasses	Broad leaved	Grasses
Premerge	6 lbs.	5	0	97.5	100.0
	6 lbs.	4	0	98.0	100.0
	6 lbs.	3	0	98.5	100.0
Premerge	4 lbs.	27	0	86.8	100.0
	4 lbs.	29	0	85.9	100.0
	4 lbs.	33	0	83.9	100.0
Control		206	3	—	—

* Average weeds per square yard computed from total weeds counted in one square yard of three replications. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table IV. Results Obtained in Studies on Weed Control in Cotton with 6 TCA or TCA like Herbicides: (1) Sodium TCA; (2) Ammonium TCA; (3) Isopropal TCA; (4) Carbide and Carbon Number 2; (5) Standard Agricultural Chemicals Number 200; (6) Chlorosal A. Values Shown are Weeds Counted on May 11, 1951.

Treatment	Rate per acre	Average Weeds per Square Yard*		Per cent of Weed Control*	
		Broad leaved	Grasses	Broad leaved	Grasses
Sodium TCA	4 lbs.	96	25	7.6	50.0
	8 lbs.	44	10	23.0	80.0
	12 lbs.	22	11	32.6	78.0
Ammonium TCA	4 lbs.	72	14	31.7	74.0
	8 lbs.	34	20	67.3	62.0
	12 lbs.	41	7	61.5	86.0
Isopropal TCA	4 lbs.	52	52	50	0
	8 lbs.	73	39	30.7	22.0
	12 lbs.	78	30	25.0	40.0
Carbide and Carbon #2	4 lbs.	86	32	17.3	38.0
	8 lbs.	42	13	59.6	74.0
	12 lbs.	41	5	60.5	90.0
Standard Agricultural Chemicals #200	4 lbs.	109	39	0	42.0
	8 lbs.	59	21	43.2	58.0
	12 lbs.	41	15	32.6	70.0
Chlorosal A	4 lbs.	95	33	9.0	34.0
	8 lbs.	60	22	42.3	56.0
	12 lbs.	57	23	45.1	54.0
Control	—	104	50	—	—

* Average weeds per square yard computed from total weeds counted in one square yard of three replications. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table V. Results Obtained in Studies on Weed Control in Cotton with 4 Herbicides: (1) Sodium TCA; (2) Sharples EC3740; (3) Maleic Hydrazide; (4) Carbide and Carbon Number 2. Values Shown are Weed Counts Made on June 8, 1950.

Treatment	Rate per acre	Average Weeds per Square Yard*		Per Cent of Weed Control*	
		Broad leaved	Grasses	Broad leaved	Grasses
Sodium TCA	4 lbs.	37	12	21.2	64.7
	8 lbs.	14	1	70.2	97.0
	12 lbs.	14	1	70.2	97.0
Sharples EC3740	4 lbs.	27	25	42.5	26.4
	8 lbs.	17	15	63.8	55.9
	12 lbs.	12	10	74.4	70.6
Maleic Hydrazide	4 lbs.	24	22	48.9	35.3
	8 lbs.	29	30	38.3	11.8
	12 lbs.	21	15	55.3	55.9
Carbide and Carbon #2	4 lbs.	1	0	97.8	100.0
	12 lbs.	20	5	57.4	88.2
Control		47	34		

* Average weeds per square yard computed from total weeds counted in one square yard of three replicate. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table VI. Results Obtained in Studies on Weed Control in Cotton with 3 Herbicides: (1) Sodium TCA; (2) Sharples EC3740; (3) Kaleic Hydrazide. Values Shown are Weed Counts Made on May 11, 1950.

Treatment	Rate per acre	Average Weeds per Square Yard*		Per Cent of Weed Control*	
		Broad leaved	Grasses	Broad leaved	Grasses
Sodium TCA	4 lbs.	88	2	47.9	76.4
	8 lbs.	72	4	57.3	52.9
	12 lbs.	53	2	68.6	76.4
Sharples EC3740	4 lbs.	21	1	87.5	88.2
	8 lbs.	9	2	94.6	76.4
	12 lbs.	0	0	100.0	100.0
	16 lbs.	0	0	100.0	100.0
	24 lbs.	0	0	100.0	100.0
Kaleic Hydrazide	4 lbs.	181	4	0.0	52.9
	8 lbs.	149	4	11.8	52.9
	12 lbs.	111	3	34.3	64.7
Control		169	8.5	—	—

* Average weeds per square yard computed from total weeds counted in one square yard of three replicate. Per cent of weed control calculated as average control minus average treated divided by average control equals per cent.

Table VII. Results Obtained in Studies on Weed Control in Cotton with Blanket and Drill Applications of the Dinitro Herbicide "Premerge". Values Shown are Weed Counts Made on May 10, 1950.

Plot No. & Treatment	Total Weeds Counted		Average Weeds per Square Yard*		Per Cent of Weed Control*	
	Broad leaved	Grasses	Broad leaved	Grasses	Broad leaved	Grasses
1 - Premerge - 6#/A Blanket application	548	1044	68	130	61.1	53.5
2 - Premerge - 6#/A Drill application	343	512	43	64	75.4	77.1
3 - Premerge - 6#/A Drill application	218	867	27	108	84.5	61.4
4 - Premerge - 8#/A Blanket application	Not recorded - - - - - - - - - - - - - - - -					
5 - Premerge - 8#/A Drill application	211	1000	26	125	85.1	55.3
6 - Premerge - 4#/A Drill application	370	1733	46	216	73.7	22.8
Control	1403	2242	175	280	--	--
Other treatments	No Cultivation or Treatments to date - - - - -					

* Average weeds per square yard computed from the total weeds counted on 27 square feet in each of 8 rows in the plot. The per cent of weed control calculated as average control minus average treated divided by average control.

Table VIII. Results Obtained in Studies on 2 Methods of Application of the Pre-emergence Chemical "Premerge". (1) Blanket Application; (2) Drill Application. Values Shown are Weeds Counted June 12, 1950.

Plot No. & Treatment	Computed Values					
	Total Weeds Counted		Average Weeds per Square Yard*		Per Cent of Weed Control*	
	Broad leaved	Grasses	Broad leaved	Grasses	Broad leaved	Grasses
1 - Premerge - 6#/A Blanket application	75	143	9	18	70.0	30.7
2 - Premerge - 6#/A Drill application	55	93	7	12	76.6	53.8
3 - Premerge - 6#/A Drill application	24	55	3	7	90.0	73.0
4 - Premerge - 8#/A Blanket application	33	119	4	15	86.6	42.3
5 - Premerge - 8#/A Drill application	46	116	6	14	80.0	46.1
6 - Premerge - 4#/A Drill application	104	97	13	12	56.6	53.8
7 - Control	243	208	30	26	--	--

* Average weeds per square yard computed from the total weeds counted on 8 square yards of each plot. The per cent of weed control calculated as average control minus average treated divided by average check.

Table IX. Results of Yield Tests on Cotton Treated with 4 Methods of Controlling Grass and Broad-leaved Weeds: (1) Blanket Application of "Premerge", Followed by Flame Cultivation; (2) Drill Application of "Premerge", Followed by Oil and Flame Cultivation; (3) Drill Application of "Premerge", Followed by Oil Only; (4) Normal Control with Hand Hoeing.

Treatment	Yield in pounds of* Seed Cotton per Acre
1 - Premerge 6#/A blanket and flame only	417
2 - Premerge 6#/A drill and oil and flame	404
3 - Premerge 6#/A drill and oil as needed	584
4 - Premerge 8#/A blanket and flame only	668
5 - Premerge 8#/A drill and oil and flame	347
6 - Premerge 4#/A drill and oil as needed	285
7 - Normal control, hand hoeing	85

* Yields were taken from 100 feet of row on each of 6 rows in the plot and calculated as pounds of seed cotton per acre.

Table X: Results Obtained from Studies with 4 Methods of Weed Control and the Cost per Acre: (1) Pre-emergence Followed by Post-emergence and Flame Cultivation; (2) Pre-emergence Followed by Post-emergence Oil; (3) Post-emergence Oil; (4) Hand Hoeing.

Treatment	Number of Treatments			Average Weeds* per 100 Feet of Row	Cost per** Acre in Dollars
	Oil	Flame	Hoeing		
Premerge 6#/A, Oil and flame	3	4	0	2.9	10.02
Premerge 6#/A, Oil	4	0	1	5.1	12.32
Premerge 8#/A, Oil and flame	3	4	0	0.86	11.13
Premerge 4#/A, Oil	4	0	1	8.9	11.22
Oil, LHKl	4	0	1	17.0	12.00
Oil, WSl918	4	0	1	20.9	12.00
Control, hand hoeing	0	0	2	13.5	17.00

* Average computed from total weeds counted on 816 feet of row per plot.

** Cost based on current 1950 prices for chemicals, fuel for flaming and labor for hand hoeing.

Table XI: Results Obtained from Studies on Injury to Cotton When Post-emergence Application of Herbicidal Oils Were Used Following Pre-emergence Treatments and Where Post-emergence Oils Were Used Alone. Values Shown are Total Number of Stalks Observed on 200 Feet of Row in Each Plot.

Treatment	Number of 5 gallon/A Applications of Oil	Total* Stalks Observed	Killed	Computed Values** Per Cent of Stand	
				Severely*** Injured	Killed or**** Injured
Dinitro 8#/A + LHHl Oil	3	710	4.2	8.4	23.9
Dinitro 6#/A + LHHl Oil	3	640	0.0	1.5	12.5
Dinitro 6#/A + LHHl Oil	4	590	8.4	20.3	67.7
Dinitro 4#/A + LHHl Oil	4	670	3.0	4.5	20.9
LHHl Oil	4	720	1.4	4.2	23.6
WS1918 Oil	4	470	2.1	0.0	12.8

* Average number of stalks per acre calculated as 41, 366.

** Percentages calculated by dividing number counted by number injured.

*** Stalks cracked and broken, plants fallen on ground.

**** Includes killed, severely injured, moderately injured (stems cracked, bent but not broken), and slightly injured (stems cracked or scarred but not bent).

Table XII. Results Obtained from Yield Tests on Cotton Treated with Pre-emergence Followed by Post-emergence Chemicals and Post-emergence Chemicals Alone. Values Shown are Yields in Pounds of Seed Cotton per Acre.

Treatment	Number of 5 gallon/A Applications of Oil	Yield in Pounds of Seed Cotton per Acre*
Dinitro 6#/A + LHHl Oil	3	1062
Dinitro 6#/A + LHHl Oil	3	1081
Dinitro 6#/A + LHHl Oil	4	882
Dinitro 4#/A + LHHl Oil	4	1212
LHHl Oil	4	1401
WS1918 Oil	4	1176
Control		1136

* Yields taken from 100 feet of row on each of 8 rows in the plot and calculated as pounds of seed cotton per acre.

Table XIII. Results Obtained from Studies on Injury to Cotton from 2 Herbicidal Oils at 2 rates of Application: (1) LHH1; (2) WS1918. Values Shown are Total Number of Stalks Observed on 200 Feet of Row in Each Plot.

Treatment and rate per acre	Total stalks* observed	Commuted Values** Per Cent of Stand		
		Killed	Severely*** injured	Killed or**** injured (total)
LHH1 - 10 gal.	680	42.6	27.9	77.9
WS1918 - 10 gal.	820	14.6	15.7	59.8
LHH1 - 5 gal.	510	15.7	9.8	37.2
WS1918 - 5 gal.	820	8.5	4.9	36.6

* Average stand per acre calculated as 52, 476.

** Percentages calculated by dividing number counted by number injured.

*** Stalks cracked and broken, plants fallen on ground.

**** Includes killed, severely injured, moderately injured (stems cracked, bent, but not broken), and slightly injured (stems cracked or scarred but not bent).

Table XIV. Results Obtained from Yield Tests on Cotton Treated with 2 Herbicidal Oils at 2 Rates of Application: (1) LHHl; (2) WS1918. Values are Yields in Pounds of Seed Cotton per Acre.

Treatment	Rate per Acre	Yields in Pounds of* Seed Cotton per Acre
LHHl	10 gallons	849
WS1918	10 gallons	1340
LHHl	5 gallons	1039
WS1918	5 gallons	993
Control		1000

* Yields taken from 100 feet of row on each of 8 rows in the plot and calculated as pounds of seed cotton per acre.

Table XV. Results Obtained from Field Scale Studies on the Control of Annual Grass and Broad-leaved Weeds in Cotton. Cotton treated with Pre-emergence and Post-emergence Chemicals. Values are Weeds Counted on August 16, 1950, Approximately 10 Days After "Layby".

Test Number, Location and Planting Date	Total Length Row Counted	Computed Values*			
		Total Weeds Counted		Average Number of Weeds per 100 Feet of Row	
		Broad leaved	Grasses	Broad leaved	Grasses
11 - Perriday 15 April	18,024	658	1420	3.65	7.88
12 - Perriday 10 May	10,808	256	398	2.37	3.68
Perriday-Control April	2,400	139	134	5.79	5.58
14 - Lake Providence	4,000	26	3	0.65	0.08
Lake Providence Control	2,000	62	3	3.10	0.11

* Average number of weeds per 100 feet of row calculated as number of weeds counted times 100, divided by the number of row feet counted.

Table XVI. Results of Yield Tests, Cost of Hand Labor and Number of Cultivations in Studies on Weed Control in Cotton Using Pre-emergence Dinitro and Post-emergence Oil Sprays.

Test No.	Pounds of Seed Cotton per Acre*	Hand Hoeing		Number Cultivation
		No. Times	Total Cost per Acre	
11 (22.5 acres)	1933	2	$8.24	4
12 (22.5 acres)	2268	1	4.35	3
Ck (77 acres)**	2433	3	8.94	7
Ck (14 acres)***	2463	3	5.89	8

* Average yield and cost of hand labor calculated from records furnished by plantation manager.

** Planted same date as Test 11.

*** Planted at approximately same date as Test 12 and cross plowed on 38 inch centers.

Table XVII. Rainfall Data Recorded at St. Joseph, Louisiana, for the Months April Through September.

April	Inches	June	Inches	August	Inches
1	1.60	1	0.23	5	0.23
3	0.19	2	0.87	9	0.28
4	0.08	3	1.01	16	0.05
11	0.24	4	0.03	17	0.19
17	0.13	6	0.29	19	0.20
18	0.48	7	0.83	25	0.05
20	0.02	20	0.85	28	0.03
24	1.03	21	0.55	29	0.27
25	0.02	Total	4.66	30	2.17
28	0.26			Total	3.47
29	1.31				
Total	5.41				

May	Inches	July	Inches	September	Inches
1	2.18	5	0.29	1	0.18
3	4.02	6	0.93	2	1.23
12	0.21	7	0.03	11	1.63
13	1.02	13	0.01	13	1.26
14	0.02	14	1.50	14	1.09
15	1.46	15	0.03	19	0.15
19	0.20	16	0.54	20	0.09
27	1.05	25	0.04	21	0.94
28	0.08	26	0.28	22	0.14
29	0.07	27	0.23	26	0.04
30	0.87	28	0.20	27	4.43
Total	11.18	29	0.76	30	0.22
		30	0.34	Total	7.40
		Total	5.08		

Total May through September 31.79.

DISCUSSION

Small Plot Studies

During the cotton growing seasons of 1948 and 1949 fiftieth acre field plots were used to study and screen the various available herbicides for weed control in cotton (8, 9). From these studies it was apparent that some of the chemicals involved in the tests showed no promise for such use. These were subsequently discarded for use in cotton. Studies with the others of this group, and with several new candidates were carried out during the 1950 season.

Further tests with the various dinitro herbicides were carried out to determine any differences in the activity of the various formulations. The results of these tests indicate that when equivalent amounts of active ingredients are used there are no significant differences in the weed control, or the response of the cotton plants (see Tables 1, 2, and 3). These data support data recorded for the 1949 season (8, 9). The data reported in 1949 indicated a more constant response than is shown in the data presented herein. However, if all of the trials are considered and the tabular data critically analyzed, real differences in the responses shown by the different formulations are difficult to define. The variable responses indicated by these data

may be the result of environmental conditions surrounding the individual tests (see Table 17).

Of the new materials tried, EC3740 and Maleic hydrazide were the only materials which had not previously been included in the field screen. Weed control with these materials was unsatisfactory (see Tables 2, 5, and 6). The results shown in Table 6 indicate excellent weed control with EC3740 at higher rates of application, but the effect on the cotton was adverse. From 4 pounds per acre to the highest rate, i. e., 24 pounds per acre, the cotton was killed out entirely. The effect of Maleic hydrazide, though not effective as a pre-emergence herbicide, was not adverse to the cotton plants at the rates of application used.

In the tests with TCA-like herbicides, no materials not previously tried were included. The results in Tables 4, 5, and 6 indicate that the materials used here are more effective for grass control than for broad-leaved weed control. This is in agreement with previous work reported on the action of this type herbicide (41, 42). Sodium and ammonium TCA, Carbon and Carbide experimental herbicide number 2 and Standard Agricultural Chemicals number 200 appeared to be equally effective at 12 pounds per acre for grass control. None of these chemicals have shown good results for broad-leaved weed control (41). Of further interest was the response of the cotton plants to these chemicals. The very wet conditions surrounding some of the tests (see Table 17) resulted in malformation of the cotton foliage. The cotton in the 4 pounds per acre tests

was not severely affected but did show mild crinkleing of the leaves and mild terminal bud malformities. As the amount of material per acre was increased, these symptoms were more abundant and the stands were moderately reduced in the 12 pound treatment (see Plate I). Though this type chemical has been suggested as a possible grass herbicide for cotton under some conditions, these results would seem to indicate an extremely limited use for such materials as pre-emergence agents in cotton. This does not necessarily mean that such chemicals would be excluded as herbicides for the control of grass weeds in the middles of cotton rows after "layby" time. However, other factors such as cost per acre, difficulty in application, etc., may preclude their use here.

From three years study with TCA and the similar compounds included in these tests (41, 42), it appears that they should be dropped from the cotton herbicidal screening tests except for reasons of comparing the effect of other newer herbicides.

One-Fourth Acre Plots and Field Scale Tests

In 1949 studies on weed control were carried out on one-fourth acre plots in order that equipment suited to complete mechanization could be conveniently applied. The purpose of these studies was to compare chemical and mechanical methods for weed control, combinations of both methods, and the use of flame cultivation for this purpose. The dinitro herbicides applied as pre-emergence sprays resulted in

satisfactory initial weed control, but appeared to be broken down, diluted, or ineffective for other reasons for several weeks. Generally the results did not show that flame cultivation could be effectively applied early enough to control subsequent weed growth without serious injury to the cotton plants. However, preliminary studies indicated that weed control during this critical period could be effectively achieved with post-emergence oil application (9, 28, 43, 44).

While carrying out these studies, problems such as conditions of the seedbed, soil moisture, and cultural practices following chemical applications were studied. Preliminary results indicated that seedbeds should be smooth and free of clods (see Plate II); that very low moisture levels in the upper layers of soil could be correlated with spray injury (9), and that the treated areas should be left undisturbed. Further, that cultivation should be in a manner so as not to place fresh soil over the treated areas or to build up barriers of soil which might interfere with subsequent post-emergence spraying.

Tests were carried out during 1950 in order that critical studies could be made of pre-emergence dinitro sprays and post-emergence oil sprays, when applied alone or in combination with each other. Some of the tests here included flame cultivation as an additive weed control measure following the various chemical treatments. One-fourth acre tests were also carried out to study the effect of certain oils on the stand and yields of cotton.

The results of two pre-emergence trials are shown in Table 7 and

8. These data in general indicate that as the amount of active ingredient is increased, the resultant weed control is relatively increased. It is also important to point out that the per cent of weed control indicated here is considerably lower than that which has been reported previously (8, 9). This result may be explained to some extent by reviewing the rainfall data presented in Table 17. It is known that the chemicals involved in the test here are water soluble and may be expected to produce less desirable weed control under conditions of high rainfall (2, 8, 9). Earlier experimental results (8) have indicated that under these conditions, practically no weed control could be expected. The data presented here seems to disprove this possibility quite conclusively. The conditions under which such dilution and run-off of the herbicidal principle occurred appeared to be loose, clody seedbeds which were readily compacted and eroded by heavy rainfall (13). Since these early experiments, all seedbeds have been rolled to smooth and compact the surface to which pre-emergence herbicidal chemicals were applied. Observations, even under high rainfall conditions, show that the germination and development of weed seedlings following pre-emergence sprays is a slow process and that the seedlings appear to be stunted (see Plate III). This action may be said to be a pre-disposing factor for the subsequent weed control measures.

Studies on the use of certain aromatic oils for post-emergence weed control have shown that these materials, when properly applied,

will effectively control weed seedlings that germinate after normal depletion of effective amounts of the dinitro herbicide (9, 13, 24, 23, 44). Even under the most adverse condition, weed germination does not occur for several weeks after application of pre-emergence sprays (9, 13, 25, 27). This allows a time interval between the germination of cotton and germination of the weed seed sufficient to gain the difference in size necessary for the application of oils without great risk of serious injury to cotton plants. Complete coverage is a requisite for effecting weed control with such a herbicide (43, 44), and this interval is a necessary part of the program, since cotton has no true physiological resistance to the oils, if they are applied in the same manner as they are applied to the weeds. The waxy stem of the cotton plant does resist the penetration of the oils, however, and this, together with the difference in the size of cotton plants and weed plants, is sufficient to insure relative safety in the use of post-emergence directed sprays of this type (9). As the oils are repeatedly applied and the cotton plants develop, this degree of resistance appears to be considerably less. Close observation of treated plots after each application of oil have shown that there is a gradual change in the plant tissue which the oil strikes, from a glossy bright green color to a dark brownish color similar to that which follows natural development of true bark. At first, this condition does not seem to affect the cambium layer of the stem, but the outer bark of the stem seems to slough off with little difficulty upon touching. This condition may be said to be one in which the cuticle is broken down by repeated

applications of the aromatics, thereby removing the natural resistance of the plant to injury. As the cotton plants continue to develop, the waxy outer layers of the stem are normally replaced by cork tissue which is often accompanied by the development of small cracks. These open tissues are more absorbent than the earlier, more compact tissues of the treated zone.

In the specific tests with the various types of oil, not enough injury was observed to record until after the cotton had been treated three or four times (except in the treatments of 10 gallons per acre), though there was a general limberness observed in all treated plants for a short while after each treatment. This effect is assumed to have resulted from the naptha elements contained in the oils. The cotton apparently soon recovered from this type of injury, with no lasting effect.

Data recorded on one-fourth acre tests, indicated that four applications of oil under some conditions can result in severe injury to the cotton stalks (see Table 13) (see Plate IV). In the treatment with LHHL at five gallons per acre, 25.5 per cent of the total stand was completely killed or severely injured. In the 10 gallons per acre treatment, 70.5 per cent of the cotton was dead or severely injured and 42.6 per cent of the stalks were dead. The WSL918 treatment of 5 gallons per acre resulted in only 13.4 per cent dead or severely injured stalks. These high rates of injury are not consistently reflected in the yield data taken from these tests (see Table 14). Significant reduction of yield is recorded only in one

treatment, i.e., 10 gallons per acre of LHHL. However, it must be noted in this respect that the average numbers of stalks per acre in these plantings were at least 100 per cent over that which is considered a normal stand, and the yields would not be expected to respond to anything less than drastic reductions in stand.

Similar data taken on tests in which oils were used to follow pre-emergence sprays (see Table 11) indicate that less injury generally accompanies only three applications. It is noted in plot three of this test that the injury is surprisingly high, without doubt the result of over application caused by slower tractor speed in a low wet area of the field. This large number of severely injured plants is also reflected in the yield data shown in Table 12. Other yields shown here indicate that there was no significant reduction in yield from either pre-emergence sprays or post-emergence applications of oil. Flame cultivation did not directly reduce yields, but is thought to aggravate injury resulting from application of oils (see Plate IV). However, weed data approximately 10 days after "layby" of the cotton showed highly significant weed control in plots where flame cultivation followed the combined use of pre-emergence and post-emergence applications of chemicals (see Table 10). One may further note that the lowest weed populations recorded at this time occurred where both types of chemical weed control were used and were followed by flame cultivation. The data reveal that successively decreasing weed control resulted from the remaining treatments in the following order: (1) plots where pre-emergence chemicals were followed with oil, (2)

normal practices where hand hoeing was the major means of weed control, and (3) where oil alone was used.

The relative cost per acre of each of these treatments is also shown in Table 10. It is pertinent to point out here that the two plots with the lowest cost per acre treatment gave the most efficient weed control. In only these two treatments was the use of hand labor unnecessary. These data further indicate that efficient use of herbicides in cotton not only results in more effective weed control but also reduces the cost of this major portion of cotton production.

To determine the practicability of weed control in cotton with chemicals, large, field scale tests were carried out. These tests included pre-emergence dinitro sprays, post-emergence oil sprays and flame cultivation in some instances. The relationship of existing agronomic practices was studied and compared with those which had appeared to yield the best results for effective weed control.

Data from the 25 acre field scale tests indicate that these practices, if properly carried out, reduce the cost and number of times that hand labor is necessary for adequate weed control. Observations indicate that the proper use of cultivating equipment throughout the entire program is extremely important. Cultivating sweeps must be set shallow so as not to push fresh soil up over the treated areas or to form ridges which interfere with post-emergence applications of oil and flame. No completely satisfactory tool has been designed for re-shaping beds that have been cultivated improperly. If fresh

soil is thrown into the treated zone, new weed seeds are deposited, and the weed control designed to deplete the treated area of germinable weed seed, is lost. Further, it is impossible to control weeds in the drills of the cotton row if they cannot be reached and covered with the chemical intended for this purpose. Proper cultivation during all of the weed control period cannot be emphasized too strongly if the full value of the methods used for weed control are to be realized (see Plate V).

From the results presented here and in previous reports (8, 9) it appears that sufficient data are available to support a tentative recommendation for the use of chemicals as a means of weed control in cotton. The results would seem to suggest the following method as the most efficient. Step one: The application of 6 to 8 pounds of dinitro herbicide per acre as a pre-emergence spray (blanket basis). The water and oil soluble forms of this chemical seem to be equally effective for weed control, when applied in 40 to 60 gallons per acre of total volume. This treatment should be applied to approximately one-third of the total area of the field, thus reducing the actual amount of herbicide and diluent used by two-thirds of the total amount indicated above. The seedbeds should be firm and free of all clods before the application of the spray materials. Step two: The application of five gallons per acre of LHH1 or WS1918 oil to a band of about 8 inches centered over the cotton drill. The operation should follow three to five weeks after the pre-emergence treatments, depending upon the rapidity and abundance of weed emergence. The application of

oils should be timed so that the weed seedlings can be covered with the oil without spraying the foliage of the young cotton plant. The smaller and more succulent the weeds are at the time of spraying, the greater is their susceptibility to the spray materials. Subsequent applications of oil should be made as they become necessary for control of weeds in the drill area. Fresh soil moved over the treated zone will undoubtedly contain weed seed and cause a reduction in the desired effect of the chemicals. Improper maintenance of the row beds will result in the build up of ridges of soil near the treated drill and will prevent the proper distribution of the oil and flame applications which follow. For cleaning the middles of the rows, sweeps should be set shallow and adjusted so as to prevent the build up of these barriers. More than three successive applications of oil appear to cause rather severe injury to the cotton stems and it is recommended that not more than three applications be used. These should be spaced one week to ten days apart, depending upon the need. Too rapid a follow up of oil sprays may tend to have an effect similar to that of over application. Step 3: After the cotton has received pre-emergence treatment and a maximum of three applications of oil, the treated zone is by this time practically free of germinable weed seed, and the problem of weed control becomes less and less difficult. Also, the cotton has reached a size which will tolerate flame cultivation. Flame should be applied as soon as possible and at intervals as needed for efficient weed control. This procedure can be followed until the foliage of the

cotton has completely covered the row at which time the shading effect reduces the number of weed seedlings which will normally germinate. Flame cultivation may be continued for varying lengths of time after this provided proper shields for protection of the cotton foliage are employed.

SUMMARY

The effect of certain chemicals on weed control in cotton were studied. Pre-emergence chemicals were compared with several post-emergence oils, and the effect of combining pre- and post-emergence methods of weed control was studied. Flame cultivation was studied as an additive weed control measure following pre-emergence applications and applications which combined pre- and post-emergence chemicals. The specific effect of oils on stand and yield of cotton was studied. One-fourth acre plots were used and field scale studies were carried out on 25 acre plots. Comparative studies on four commercially available dinitro herbicides were carried out on fiftieth acre plots. Further studies with the trichloroacetate-like compounds and other new herbicidal candidates were made.

It was found that the dinitro compounds applied at 6 to 8 pounds per acre gave from fair to excellent weed control in the one-fiftieth acre plots. Where one-fourth acre plots were used, the initial weed control was not as good, but the effect of these chemicals was pre-disposing to the subsequent post-emergence application.

In studies in which oil alone was used the weed control was less desirable than in routine practices and where as many as four applications were used, severe injury and reduction in stand occurred.

Where pre- and post-emergence methods were used and followed

by flame cultivation, the results were excellent. The advantages of pre-emergence chemicals followed by post-emergence oils were clearly indicated. Flame cultivation following these measures has been shown to be of definite value. Only where these three methods were combined was it possible to produce cotton without any hand labor.

The studies on large field scale plots indicated adequate weed control resulting from the methods employed and reduction in the amount of hand labor required for large scale production of cotton. The condition of the seedbed at the time of application is discussed and the importance of subsequent cultural practices is stressed. A tentative method for complete weed control in cotton has been suggested.

CONCLUSIONS

1. Application of dinitro herbicides at 6 to 8 pounds per acre resulted in satisfactory weed control for a period of 3 to 5 weeks when applied to properly prepared seedbeds.
2. When three applications of LHHl or WS1918 oil were used following pre-emergence sprays, weed control was satisfactory, and serious injury to the stand and yield did not result. If more than three applications of oil were applied, severe injury to the stands occurred, and in some cases reductions in yields followed.
3. Flame cultivation following the application of pre- and post-emergence chemicals provided adequate weed control to carry cotton to maturity.
4. No method described herein has resulted in completely satisfactory weed control when applied as a separate means of weed control. When the three methods described, i.e., pre-emergence and post-emergence chemicals and flame cultivation, were applied together at the appropriate time and in the proper manner, satisfactory weed control resulted.

Plate I. Showing Injury to Stand and Poor Weed Control Resulting from 12 Pounds per Acre of Sodium TCA. Treated Left of Stake "3", Untreated Right.

Plate II. Showing Tractor Drawn Sprayer Spraying Four Cultipacked Rows with Pre-emergence Chemical.

Plate III. Showing Results of Pre-emergence, Drill Application of "Premerge". Treated April 15, Photo May 20. Treated 12-14 Inches Right of Stake, Untreated Middle Left of Stake.

Figure 1

Figure 2

Figure 3

Figure 4

Plate IV. Showing Stem Injury Resulting from Post-emergence Directed Applications of Herbicidal Oil. Figure 1. LHHl, 5 Gallons per Acre, 3 Applications. Figure 2. LHHl, 5 Gallons per Acre, 3 Applications Followed by 4 Flame Cultivations. Figure 3. LHHl, 5 Gallons per Acre, 4 Applications. Figure 4. LHHl, 10 Gallons per Acre, 4 Applications.

Plate V. Showing Results of Pre-emergence Application Followed by One Post-emergence Application of Oil. Uncultivated Control on Left. Treated, Middles Cultivated, Drills Undisturbed, on Right.

SELECTED LITERATURE

1. Albert, W. B. Progress report on chemical weed control experiments at Clemson, South Carolina. Proc. Southern Weed Conf. 2: 98-101. 1949.

2. Barrons, K. C. Pre-emergence weed control. Down to Earth 3 (3): 2-4. 1947.

3. _____. Weed control by pre-emergence spraying. Down to Earth 3 (2). 1947.

4. _____. Pre-emergence weed control 1. Down to Earth 4 (3): 2-4. 1948.

5. _____. Mullison, W. R. and Coulter, L. L. Residual pre-emergence control with phenolic herbicides. Res. Rept. North Central Weed Cont. Conf. 5: 38. 1948.

6. _____, and Grigsby, B. H. Control of weeds in canning peas with chemical sprays. Mich. Agr. Exp. Sta. Quar. Bull. 28. 1945.

7. Bould, K. and Schultz, E. S. Control of late blight tuber rot by killing tops with weed killers. Me. Agri. Exp. Sta. Bull. 438. 535. 1945.

8. Cowart, L. E., Stamper, E. R., and Creasy, L. E. Weed control studies on cotton. Proc. Southern Weed Conf. 2: 66-67. 1949.

9. _____, L. E. Creasy and E. R. Stamper. Studies on the control of annual weeds in cotton. Proc. Southern Weed Conf. 3: 70-77. 1950.

10. _____, _____. A tentative recommendation for weed control in cotton. Proc. Southern Weed Conf. 4: 88-89. 1951.

11. Crafts, A. S. Weed control in the tropics. Sci. 107: 196-197. 1948.

12. Creasy, L. E., J. L. Saille and L. E. Cowart. Cultural and application techniques for chemical weed control in cotton. Proc. Southern Weed Conf. 4: 44-46. 1951.

13. _____, W. G. Hormand and L. E. Cowart. Pre- and post-emergence and flame cultivation for weed control in cotton. Proc. Southern Weed Conf. 4: 60-63. 1951.

14. Davis, Noll P., Jr. and Paul J. Talley. Pre-emergence tests on cotton. Proc. Southern Weed Conf. 3: 61-67. 1950.

15. Hamner, C. L. and Tukey, H. B. The herbicidal effect of 2,4-Dichlorophenoxyacetic acid and 3,4,5-Trichlorophenoxy-acetic acid for bindweed. Sci. 100: 154-155. 1944.

16. Harris, V. C., F. E. Edwards and O. A. Leonard. Preliminary study on the effect of ammonium dinitro-secondary-butyl phenate on hill-dropped cotton. Proc. Southern Weed Conf. 3: 68-69. 1950.

17. _____. Weed control without the aid of cultivation. Proc. Southern Weed Conf. 4: 85-86. 1951.

18. Hedlin, W. A. Chemical weed control in onions. Proc. Amer. Soc. Hort. Sci. 51: 501-504. 1948.

19. Helgeson, E. A. and Gebrecket, D. Chemical Control of annual weeds in flax and grain fields. N. D. Agri. Exp. Sta. Bi-Mo. Bull. 3(2): 7-2. 1940.

20. Hildebrand, A. N., Chemical control of weeds. Proc. Amer. Soc. Hort. Sci. 50: 383-391. 1948.

21. _____. War on weeds. Sci. 103: 465-492. 1946.

22. Hinkle, D. A. Chemical weed control experiments in cotton for 1950 Proc. Southern Weed Conf. 4: 70-78. 1951.

23. _____, W. F. Buchele and H. S. Stanton. Mechanized production of cotton. Arkansas Exp. Sta. Rept. Series No. 22. Feb. 1951.

24. Holstun, J. T., Jr. and W. K. Porter, Jr. Screening studies for post- and pre-emergence herbicides in cotton. Proc. Southern Weed Conf. 4: 47-52. 1951.

25. Leonard, O. A., Arle, H. F. and Harris, V. C. Sinox W and Dow Selective as pre-emergence herbicides for cotton. Proc. North Central Weed Cont. Conf. 4:250. 1948.

26. _____, _____, and _____. Dow Selective and Sinox W. as pre-emergence herbicides for large-seeded crops. Proc. North Central Weed Cont. Conf. 4: 249. 1948.

27. _____. Pre-emergence control of weeds. Proc. Southern Weed Cont. Conf. 2: 35-36. 1949.

28. _____, and V. C. Harris. The effect of certain hydrocarbon compounds upon the hypocotyles of cotton and soybeans and upon the shoots of nut grass and Johnson grass. Proc. Southern Weed Conf. 3: 91-102. 1950.

29. Litzenberger, S. C., Post, A. R. and Bingham, G. H. Controlling broad-leaved annuals and biennial weeds with Sinox. Mont. Agri. Exp. Sta. Bull. 403. 1945.

30. Loehman, William H. Pre-emergence spraying for weed control in vegetables. Proc. Amer. Soc. Hort. Sci. 49: 339-342. 1947.

31. McMurray, S. P. A progress report on chemical weed control in cotton in Tennessee. Proc. Southern Weed Conf. 4: 67. 1951.

32. Nation, H. A. and J. W. Gibson. Some suggestions concerning soil preparation and equipment for residual pre-emergence weed control with chemicals. Proc. Southern Weed Conf. 4: 42-43. 1951.

33. Porter, W. K., Jr., J. T. Holstun, Jr., O. B. Wooton, Jr., and J. K. Jones. The comparison and evaluation of chemical and mechanical methods of weed control in cotton. Proc. Southern Weed Conf. 4: 64-69. 1951.

34. _____, and _____. Reaction of cotton and some common weeds to various naphtnene concentrations in post-emergence herbicidal oil. Proc. Southern Weed Conf. 4: 57-59. 1951.

35. Ratcliff, R. Y., L. E. Creasy and L. E. Cowart. The effect of various aromatic oils on stands and yields of cotton. Proc. Southern Weed Conf. 4: 53-56. 1951.

36. Robbins, W. W., Crafts, A. A. and Raynor, R. N. Weed Control. McGraw Hill. 1942.

37. Schaffer, John Jr. Pre-emergence sprays for weeding asparagus seedlings. Proc. Amer. Soc. Hort. Sci. 48: 405. 1946.

38. Scholl, J. N. and Searcy, V. S. Effect of chemical pre-emergence weed control treatments on stands of weeds and yields of peanuts. Proc. Southern Weed Conf. 2: 40-42. 1949.

39. Schwendiman, A., Torrie, J. H. and Briggs, J. M. Effect of Sinox, a selective weed spray on legume seedlings and crop yields. Journal Amer. Soc. Agron. 35: 440-444. 1945.

40. Shaw, W. C. and Willard, C. J. The effect of new chemicals on corn and soybeans when applied as pre-emergence sprays. Res. Report North Central Weed Cont. Conf. 5: 13. 1948.

41. Stamper, E. R., L. E. Cowart and T. C. Ryker. Studies on the comparative efficiency of various herbicides on grasses and other weeds. Proc. Southern Weed Conf. 3: 15-17. 1950.

42. _____, _____ and _____. Comparative efficiency of certain herbicides in 1950. Proc. Southern Weed Conf. 4: 15-17. 1951.

43. Talley, Paul J. Tentative recommendations for weed control in cotton. Miss. Agri. Exp. Sta. Bull. 471. March, 1950.

44. _____, Walter K. Porter, Jr. and Nall P. Davis, Jr. Post-emergence control studies in cotton. Proc. Southern Weed Conf. 3: 78-90. 1950.

45. Talley, Paul J. A proposed method for the control of weeds and grasses in cotton. Proc. Southern Weed Conf. 3: 103-113. 1950.

46. _____. Equipment for post-emergence control and research and its use. Proc. Southern Weed Conf. 3: 116-131. 1950.

47. Van Overbeek, J. Use of synthetic hormones as weed killers in tropical agriculture. Economic Bot. 1(4): 446-459. 1947.

48. Warren, G. F. The value of several chemicals as selective herbicides for vegetable crops. Proc. Amer. Soc. Hort. Sci. 47: 415-420. 1946.

49. _____, and Bucholtz, K. P. Weed control in cannery peas using dinitro sprays. Proc. Amer. Soc. Hort. Sci. 49: 347-350.

50. Weagate, W. A. and Raynor, R. M. A new selective spray for the control of certain weeds. Calif. Exp. Sta. Bull. 634: 1-36. 1940.

51. Zimmerman, P. W. Selective weed control. Nat. News. Winnepeg, Manitoba. June, 1944.

AUTOBIOGRAPHY

Linton Ealie Cowart was born November 3, 1919, at Bush, Louisiana. He was graduated from Covington High School in June, 1937. He entered Louisiana State University and Agricultural and Mechanical College in September, 1938, and completed three and one-half years of undergraduate work. He served in the Army of the United States from July, 1942, to March, 1946. In June, 1946, he accepted a position as Superintendent and Landscape Architect at the Woodlawn Memorial Park in New Orleans, Louisiana. In June, 1947, he re-entered Louisiana State University and received the Bachelor of Science degree from the College of Agriculture in June, 1948. He began graduate study at the Louisiana State University in June, 1948, and was awarded the Master of Science degree in August, 1949. He continued his graduate study at the Louisiana State University and is a candidate for the Doctor of Philosophy degree in August, 1951.

EXAMINATION AND THESIS REPORT

Candidate: **Linton Eslic Cowart**

Major Field: **Botany**

Title of Thesis: **,The Chemical Control of Annual Weeds in Cotton**

Approved:

John P. Shilton
Major Professor and Chairman

Richard J. Russell
Dean of the Graduate School

EXAMINING COMMITTEE:

Clara Brown

C. W. Edgerton

Lewis K. Klein

W. K. Williams

Arthur R. Schmidt

L. L. Forbes

Date of Examination:

July 23, 1951